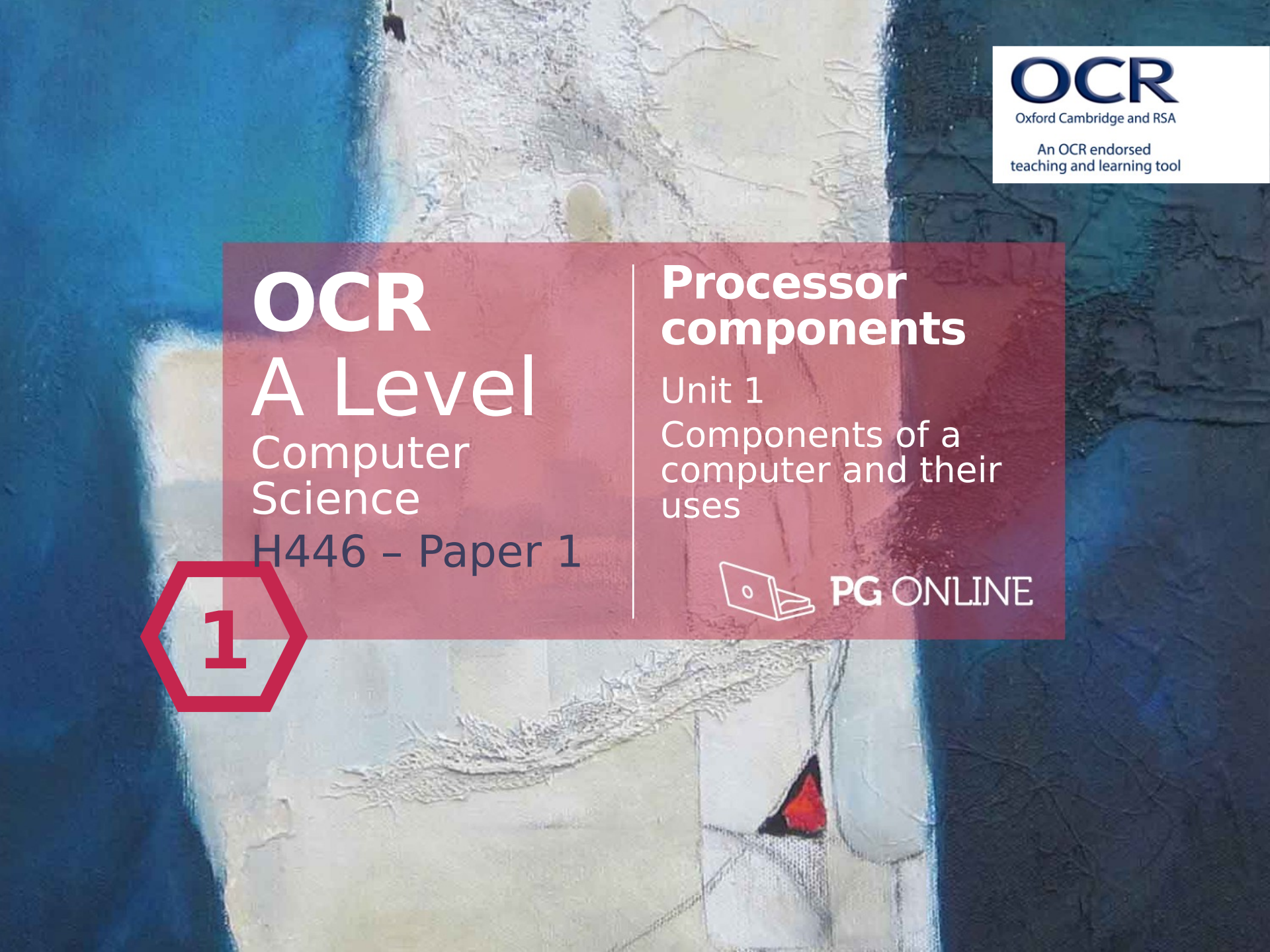

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H446 – Paper 1

1

Processor components

Unit 1

Components of a computer and their uses

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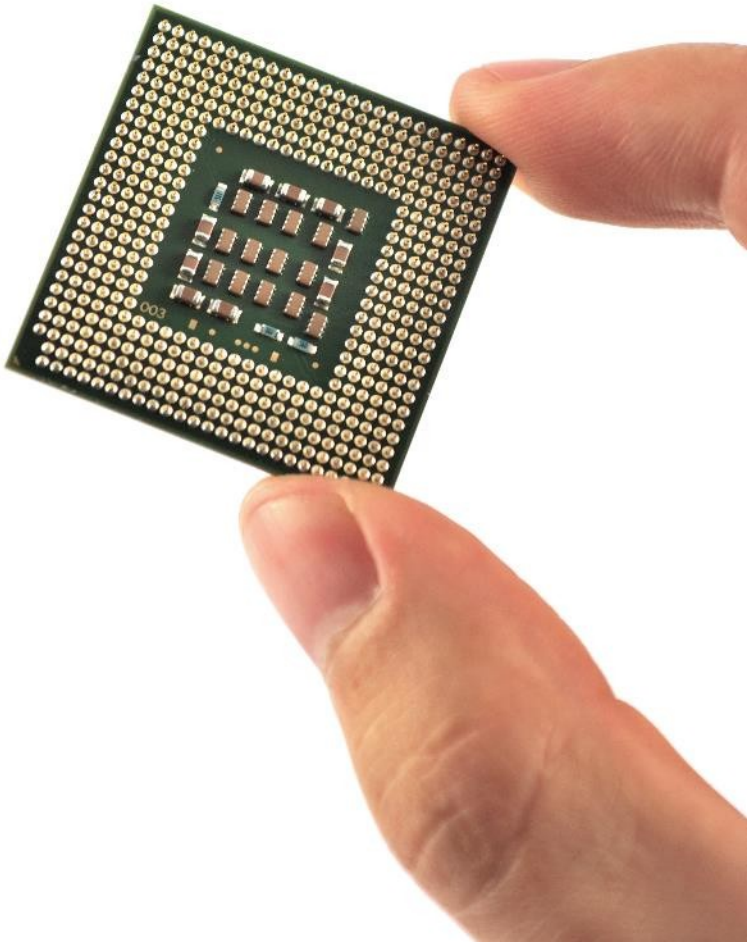
Objectives

- Describe the function of the ALU and Control Unit
- Describe the Fetch-Execute cycle and the role of the following registers:
  - Program counter
  - Accumulator
  - Memory Address Register
  - Memory data register
  - Current instruction register

Central Processing Unit (CPU)

- The processor (also called the Central Processing Unit or CPU) has a number of different components, each with their own role to perform:
  - Control Unit
  - Buses
  - Arithmetic-Logic Unit (ALU)
  - Dedicated registers

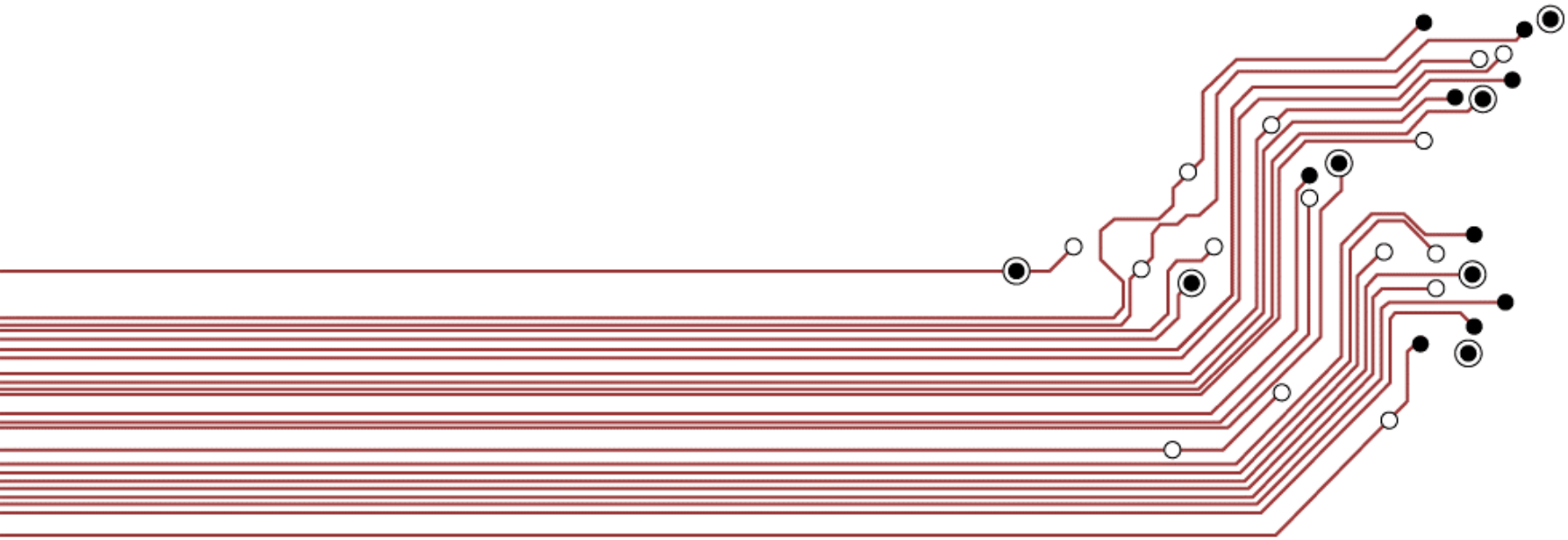


Control unit

- The part of the processor that coordinates the activity of all other components
  - Control signals are sent along the **control bus** between the control unit and the other components of the computer

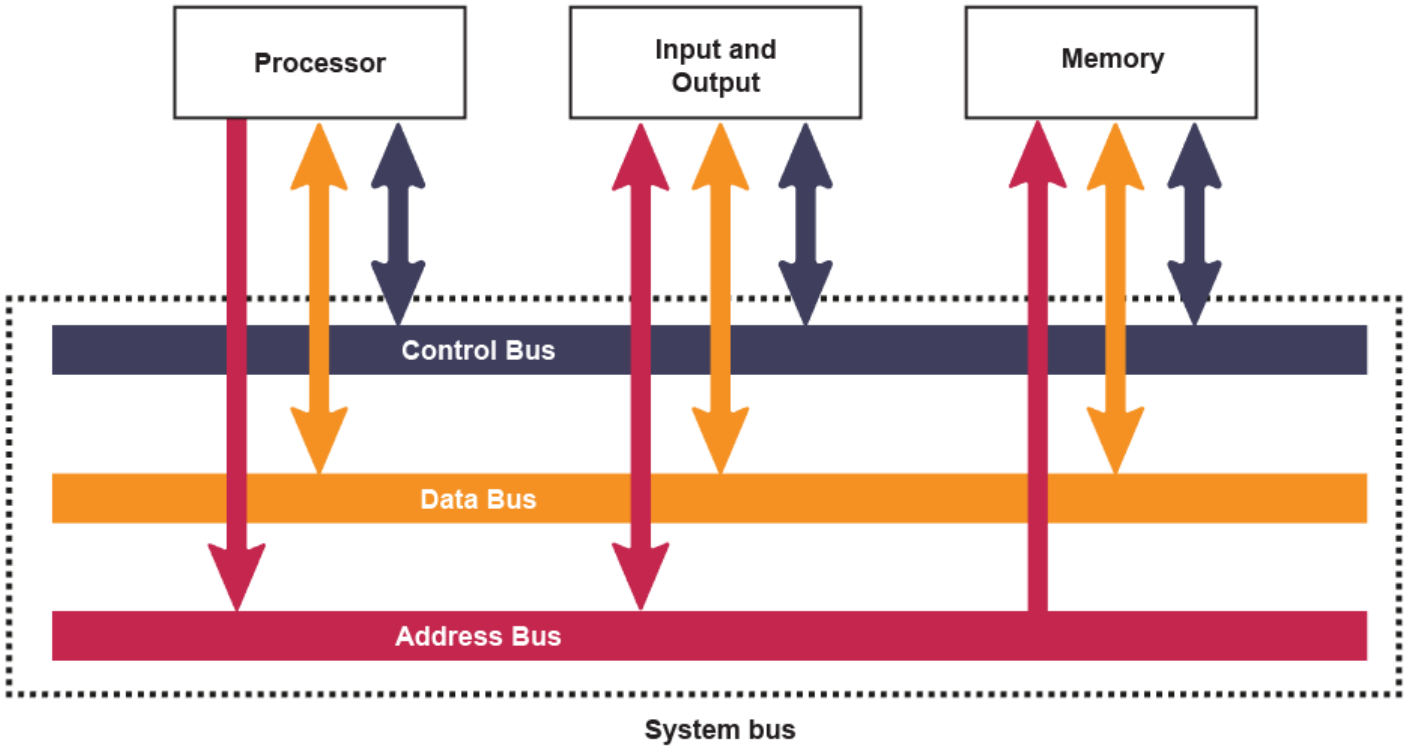
What is a bus?

- Buses in a computer consist of a series of connectors that transfer signals between internal components



System bus

The system bus consists of three separate buses carrying control signals, addresses and dat~

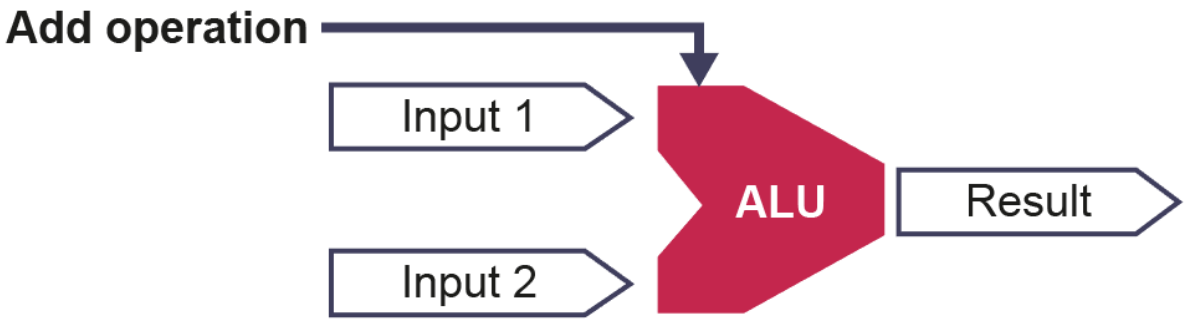


Control signals include…

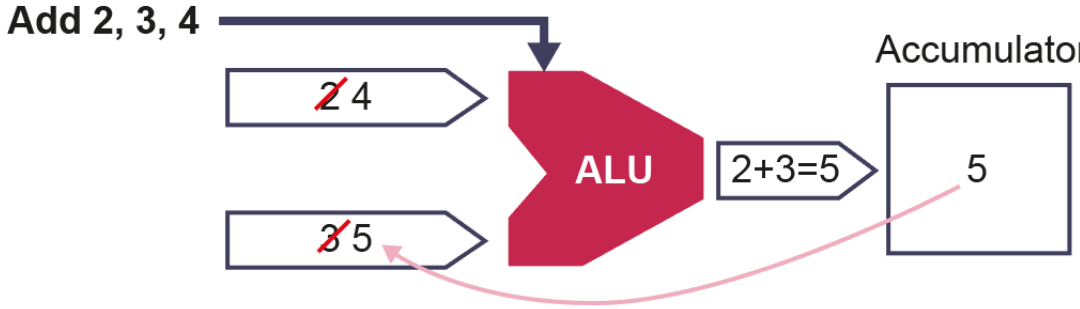
- Memory read: causes data from the addressed location in RAM to be placed on the data bus
- Memory write: causes data on the data bus to be written into the addressed location in RAM
- Bus request: indicates that a device is requesting use of the data bus
- Bus grant: indicates that the CPU has granted access to the data bus
- Clock: used to synchronise operations

Arithmetic-Logic Unit (ALU)

- The problem solving part of the processor
  - This component performs arithmetic, logical and shift operations on data
  - Arithmetic operations: Add, Subtract, Multiply and Divide
  - Logical operations include: AND, OR, NOT, XOR
  - Shift operations: Move bits to the left or right within a



The accumulator

- Results from the ALU need to be stored somewhere
  - Rather than writing working data back to ‘slow’ memory, processors have several locations of super-fast memory called **registers** that are used to temporarily store results
  - The processor is then able to immediately access and re-use these results in subsequent calculations, e.g. Add 2 + 3 + 4
  - 

    or has a

Executing instructions

- Carrying out a sequence of programming instructions requires many different pieces of information to be held
- The processor has to temporarily hold the current instruction being executed
- It has to hold the address of the data that it needs, and also the data itself
- It has to keep track of the address of the next instruction to be executed

Dedicated registers

Dedicated registers used by the processor include:

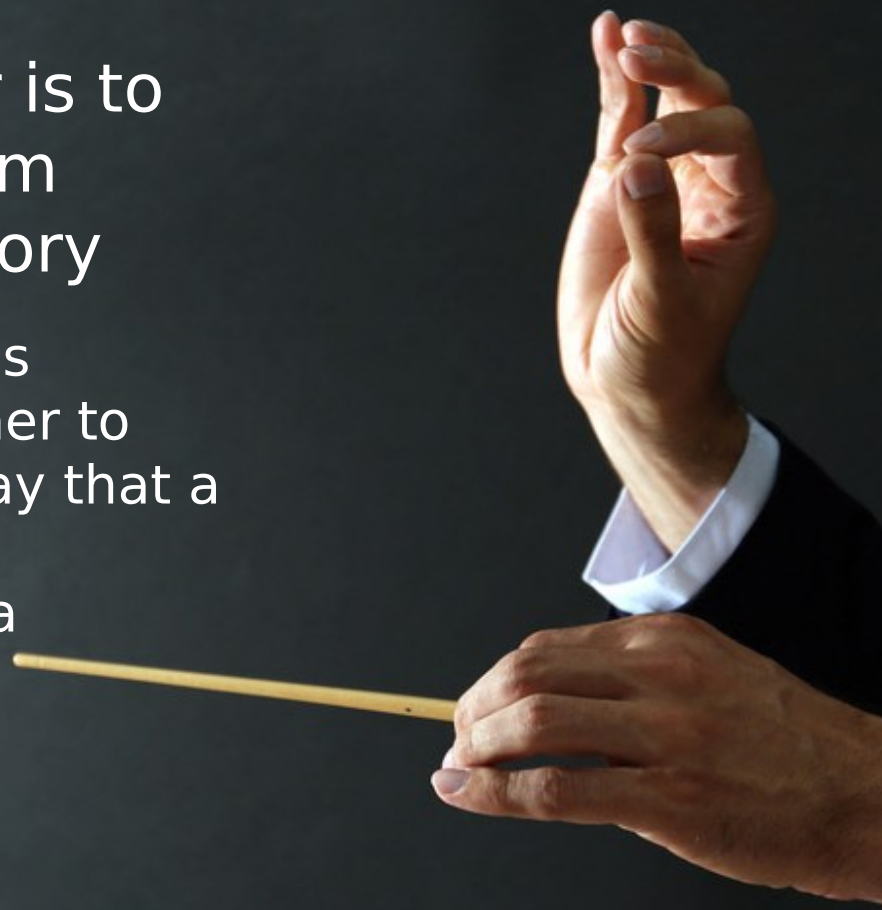
- **Program counter (PC)** – holds the memory address of the next instruction to be executed
- **Current Instruction Register (CIR)** – holds the current instruction, which is split into **opcode** and **operand**
- **Memory Address Register (MAR)** - holds the address in memory where the processor is required to fetch or store data from or to
- **Memory Data Register (MDR)** – temporarily holds data moving between the processor and main memory
- **Accumulator** – to hold intermediate results of an instruction

The processor

- Complete **Task 1** of **Worksheet 1A**

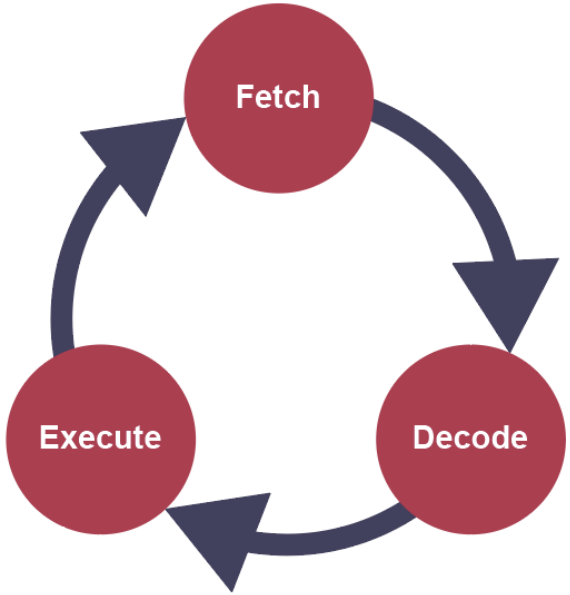
Executing instructions

- The role of the processor is to carry out instructions from programs stored in memory
  - The Control Unit coordinates components to work together to achieve this in the same way that a conductor controls all the components of an orchestra



Fetch-execute cycle

- Processors operate in defined stages that are used to carry out program instructions
  - The process is repeated over and over again for each instruction in a program

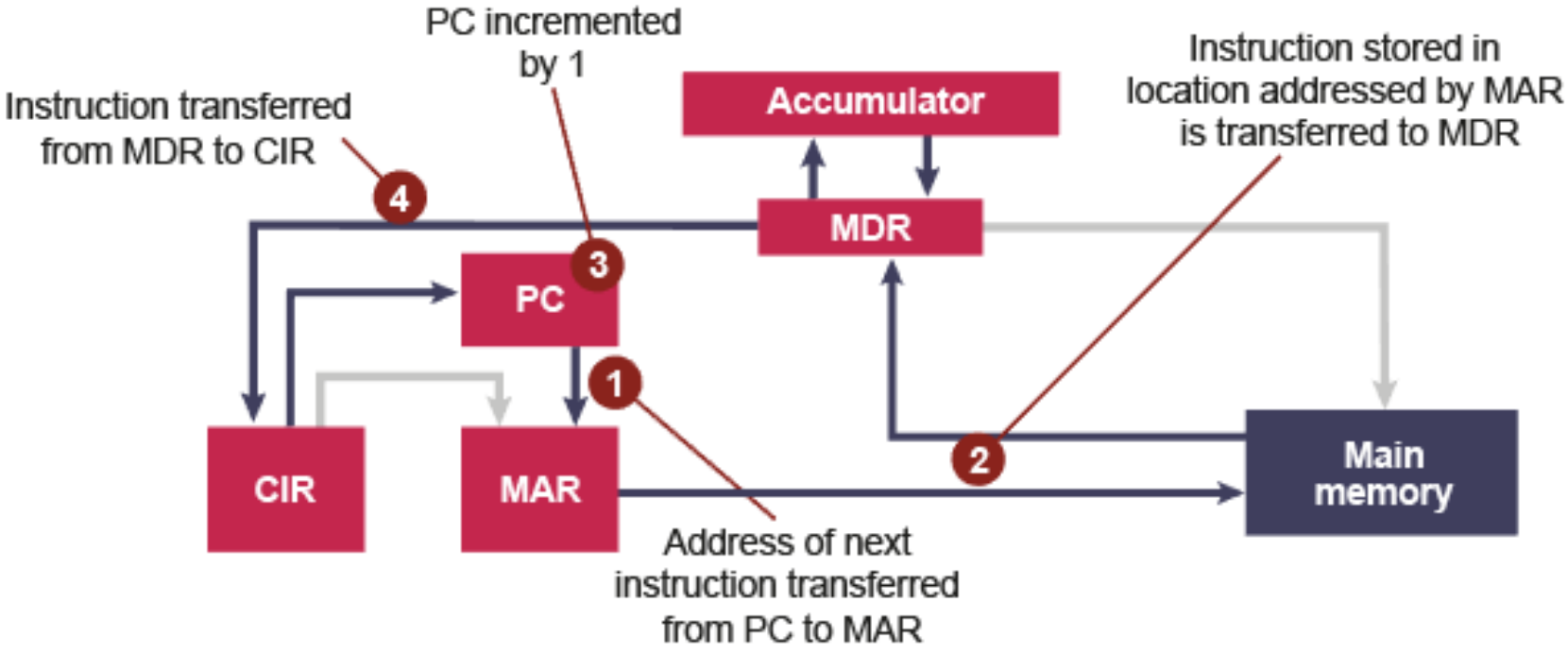


Fetch: Steps 1 - 4

1. The address of the next instruction is copied from the PC to the Memory Address Register (MAR)
2. The instruction held at that address is copied to the Memory Data Register (MDR)
3. Simultaneously, the contents of the Program Counter (PC) are incremented
4. The contents of the MDR are copied to the current Instruction Register (CIR)

Fetch: (Steps 1 – 4)

- Note: Blue lines show connections along which data is travelling in this stage



Decode: Steps 5 – 7

5. The instruction held in the CIR is decoded
6. It is split into operand and opcode to determine the type of instruction it is. Additional data, if required, is fetched from memory…
7. and passed to the accumulator

- The opcode specifies the operation that is to be carried out
- The operand holds either:

  The address of the data to be used, which is then copied to the MAR, *or*

  The actual data to be operated on, which is passed

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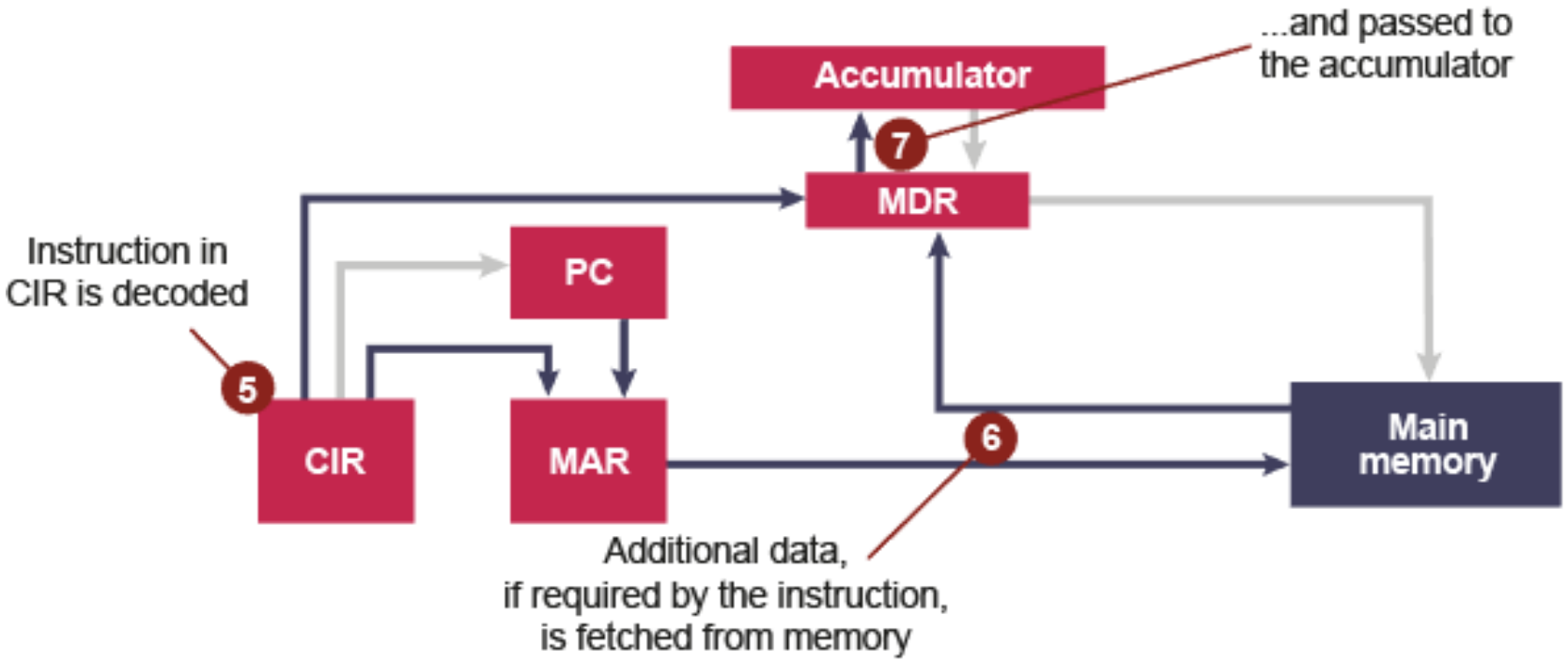
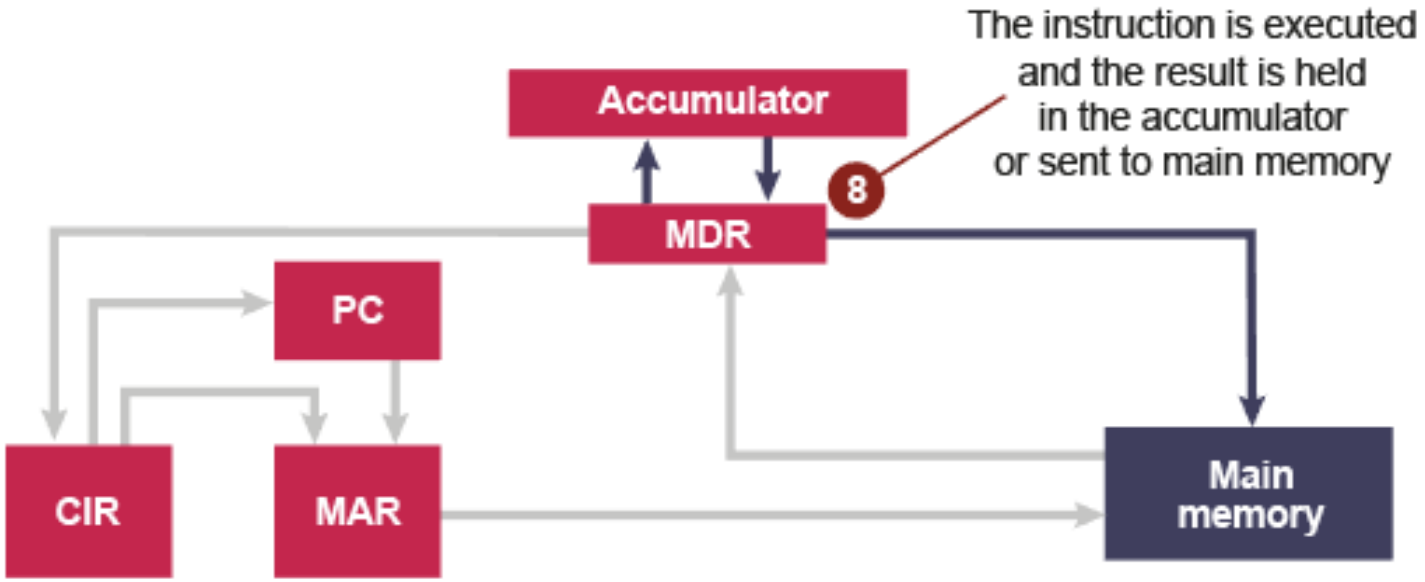
Decode: (Steps 5 – 7)

- With the instruction now in the CIR, the Control Unit can work out what needs to be done to carry it out



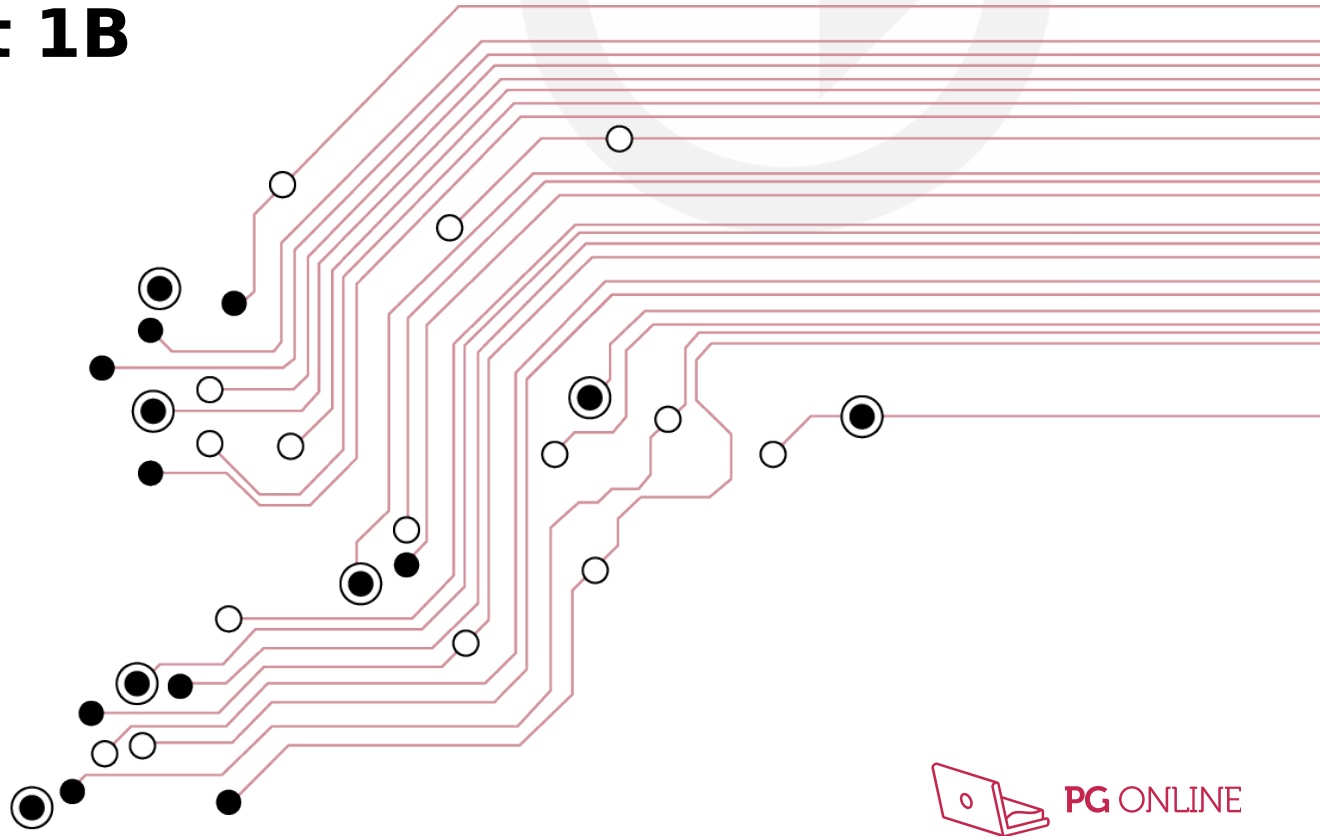
Execute: (Step 8)

- The instruction is executed and the result held in accumulator or stored in memory



Worksheet 1A

- Complete **Task 2**
- **Extension task:** For a challenge, try **Worksheet 1B**



Plenary

- The main components of the processor are:
  - ALU
  - Control Unit
  - registers
  - System bus
- Can you name the three buses making up the system bus?
- Can you name five special registers involved in the fetch-execute cycle?

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